IN THE SPECIFICATION:

Please amend paragraph **[0002]** as follows:

[0002] State of the Art: Photolithography is commonly used during the fabrication of integrated circuits on semiconductor wafers and other bulk substrates comprising a layer of semiconductor material. During photolithography, a form of radiant energy is passed through a radiation-patterning tool onto a radiation-sensitive material, commonly referred to as photoresist, which is placed upon a surface of a semiconductor wafer. The radiation-patterning tool is commonly known as a photomask or reticle. The term "photomask" is used to reference a structure~~which~~ <u>that</u> performs a function of masking or defining a pattern over an entire semiconductor wafer while the term "reticle" is used to reference a structure~~which~~ <u>that</u> functions to define a pattern over a portion of a wafer.

Please amend paragraph **[0003]** as follows:

[0003] Radiation-patterning tools contain light-restrictive regions and light-transmissive regions. Light-restrictive regions may be, for example, opaque or partially light transmissive. The light-transmissive regions or portions of a radiation-patterning tool, in conjunction with the light-restrictive regions, cooperatively facilitate the formation of a desired pattern on a semiconductor wafer. For the formation of patterns on a semiconductor wafer, the wafer is coated with a layer of radiation-sensitive material (e.g., photoresist). Subsequently, radiation passes through the~~radiation-patterning~~ <u>radiation-patterning</u> tool onto the layer of photoresist and transfers onto the photoresist a pattern defined by the radiation-patterning tool. Using a form of a photographic process, the photoresist is then developed to remove either the portions exposed to the radiant energy in the case of a "positive" photoresist or the unexposed portions when a "negative" photoresist is utilized. The residual photoresist pattern thereafter serves as a mask for a subsequent semiconductor fabrication process.

Please amend paragraph **[0006]** as follows:

[0006] Following creation and verification of the design, optical proximity correction 12 accounts for various interference factors that influence radiation passing through the radiation-patterning tool. Such interference factors may include constructive and destructive interference effects resulting as the radiation wavelength approximates the dimensions of portions of the profiles or elements of the radiation-patterning tool. Optical proximity correction modifies the profile or element dimensions to shapes such that a resultant ~~pattern~~ patterned photoresist more closely approximates the desired pattern. The processes of designing, verifying and optically correcting a design are typically accomplished primarily through the use of software, such as is available from Synopsys Corporation of Mountain View, California.

Please amend paragraph **[0008]** as follows:

[0008] FIG. 2 illustrates an exemplary apparatus 14 in which a radiation-patterning tool is utilized for a patterning process. Apparatus 14 comprises a radiation source 16 ~~which~~ that generates radiation 18 and further includes a radiation-patterning tool 20 through which radiation 18 is passed. A semiconductor wafer or substrate 22 includes a radiation-sensitive layer 24 thereon. As illustrated, radiation 18 passes through radiation-patterning tool 20 and impacts radiation-sensitive ~~material~~ layer 24 to form a pattern. This process of forming a pattern on a radiation-sensitive material with a radiation-patterning tool is commonly referred to as a printing process.

Please amend paragraph **[0009]** as follows:

[0009] A radiation-patterning tool 20 typically includes an obscuring material ~~which~~ that may either be an opaque (e.g., chrome) or a ~~semiopaque~~ semi-opaque material placed over a transparent material (e.g., glass). Radiation-patterning tool 20 is illustrated in FIG. 2 as having a front side 28 for forming features or windows and an opposing back side 26. Some radiation-patterning tools further utilize both the front side and backside for the formation of windows.

Please amend paragraph **[0010]** as follows:

[0010] Radiation-patterning tool 20 typically has a pattern with dimensions on the order of, or smaller than, the wavelength of radiation passing through the radiation-patterning tool. Therefore, interference effects may occur when radiation passes through the radiation-patterning tool and exits onto the radiation-sensitive material. Accordingly, the pattern of the radiation-patterning tool must be modified to compensate for such interference effects. FIG. 3 illustrates an exemplary pattern 30 desired to be formed on the radiation-sensitive material by subsequent semiconductor processes. Due to the interference effects, pattern 30 cannot be directly utilized but must undergo the optical proximity correction 12 of FIG. 1. Pattern 32 illustrates a corrected pattern ~~which~~ that accommodates the interference effects resulting from near-wavelength dimension patterns.

Please amend paragraph **[0011]** as follows:

[0011] FIG. 4 illustrates a radiation-patterning tool 34 and further illustrates elements utilized to create the targeted or printed images. In the exemplary printing process, a radiation-sensitive material 38 is illustrated as having formed therein a plurality of repeating patterns 40, illustrated as circular in dimension, which may be used, for example, in the formation of contact openings. One of the patterns 40 is illustrated as being centered around a location 42 while another one of the repeating patterns is illustrated as being centered around a location 44. Still referring to FIG. 4, radiation-patterning tool 34 includes a plurality of repeating elements 36 ~~which~~ that are in a ~~one-to-one~~ one-to-one correspondence with patterns 40 formed on the radiation-sensitive material 38. As shown, each of elements 36 is approximately square in shape ~~which,~~ that, when passing radiation therethrough, forms the circular patterns 40 on radiation-sensitive material 38. Elements 36 on the ~~radiation-patterning~~ radiation-patterning tool 34 may be either more transparent to radiation than surrounding regions or less transparent, depending on whether the radiation-sensitive material 38 is implemented as a positive or negative photoresist material. When elements 36 are more transmissive

to radiation than surrounding regions, elements 36 effectively act as windows ~~which~~ that allow radiation to pass through onto the radiation-sensitive material 38.

Please amend paragraph **[0013]** as follows:

[0013] FIGS. 5-7 further describe sidelobe convergence in additional detail with respect to the interference effects of radiation having a wavelength that is on the order of the dimensions of the desired pattern. In FIG. 5, the electric field strength of radiation passing through an element 36 (FIG. 4) is diagrammatically illustrated for forming a pattern 40 (FIG. 4) centered around a location 42. As illustrated, a large, positive field strength occurs at ~~location 42~~ location 42, which creates undesirable sidelobes 46. A large, positive field strength centered around location 42 may be referred to as a primary lobe while the lobes or concentrations of energy centered away from the primary lobe are referred to as sidelobes 46.

Please amend paragraph **[0015]** as follows:

[0015] Identification of locations where sidelobes may combine to form a printed feature has been undertaken and, when such locations are identified, a radiation-patterning tool can be modified to prevent the undesired combination of sidelobes. FIG. 8 illustrates an arrangement 54 ~~which~~ that identifies design elements illustrated as ~~a design feature~~ design features 56 corresponding to elements 36 (FIG. 4) of a radiation-patterning tool. One prior approach for identifying locations includes a mathematical calculation performed on the spatial characteristics of design features 56 to create a common region 58 extending between design features 56. From the region 58, a sidelobe inhibitor 60 may be calculated. The sidelobe inhibitor is utilized to prevent formation of an undesired printed feature from occurring at the location where sidelobes converge.

Please amend paragraph **[0018]** as follows:

[0018] A method and system for sidelobe suppression in a ~~radiation patterning~~ radiation-patterning tool is provided. In one embodiment of the present invention, a method for mitigating sidelobe artifacts in a ~~radiation patterning~~ radiation-patterning process is described. Elements to be formed in a radiation-patterning tool are defined as a function of the radiation ~~wavelength~~ wavelength, which creates a desired pattern along with resultant sidelobes. Diffraction rings are calculated about each of the elements to identify where sidelobe interference zones and intersections of diffraction rings are located. Sidelobe inhibitors are located at the identified locations.

Please amend paragraph **[0020]** as follows:

[0020] In yet another embodiment of the present invention, a method for designing a mask for illuminating a pattern defines elements to be formed in a mask. Diffraction rings about each of the elements ~~which~~ that coincide with the locations of sidelobes about the elements are calculated. Sidelobe inhibitors are formed at intersections of the diffraction rings of adjacent elements.

Please amend paragraph **[0022]** as follows:

[0022] A computer-readable media embodiment of the present invention is also provided for determining the placement of sidelobe inhibitors relative to elements to be formed on a ~~radiation-patterning~~ radiation-patterning tool. Diffraction rings are calculated ~~which~~ to coincide with an approximate location of radiation sidelobes, with the intersection of overlapping diffraction rings identified as locations for placement of sidelobe inhibitors.

Please amend paragraph **[0024]** as follows:

[0024] FIG. 1 is a flow chart of a prior art method of forming a radiation-patterning tool;

Please amend paragraph **[0025]** as follows:

[0025] FIG. 2 is a cross-sectional view ~~of an~~ of a prior art apparatus utilized in printing a pattern on a radiation-sensitive material utilizing a radiation-patterning tool;

Please amend paragraph **[0026]** as follows:

[0026] FIG. 3 is a view of a desired prior art pattern ~~and an~~ and a prior art element utilized for producing the pattern;

Please amend paragraph **[0027]** as follows:

[0027] FIG. 4 is a top view of a prior art pattern in a radiation-sensitive material together with a top view of a prior art radiation-patterning tool utilized for forming the pattern;

Please amend paragraph **[0028]** as follows:

[0028] FIG. 5 is a graphical illustration of radiation field strength across a substrate of an electrical field associated with radiation passing through a prior art radiation-patterning tool;

Please amend paragraph **[0029]** as follows:

[0029] FIG. 6 is a graphical illustration of radiation intensity across a substrate of an electrical field associated with radiation passing through a prior art radiation-patterning tool;

Please amend paragraph **[0030]** as follows:

[0030] FIG. 7 is a graphical illustration of radiation intensity across a substrate and further illustrates a combination of intensities from two combining fields passing through a prior art radiation-patterning tool;

Please amend paragraph **[0035.1]** as follows:

[0035.1] ~~FIG. 12~~ FIG. 12A is an enlarged view of a sidelobe convergence location illustrated in FIG. 12; and

Please amend paragraph **[0038]** as follows:

[0038] FIG. 10 illustrates a geometric method for mitigating sidelobe artifacts in a radiation-patterning process, in accordance with an embodiment of the present invention. The present method generates a mathematical method or construct 64 ~~which~~ that includes design features 66. One methodology of the present invention determines which features 66 are adjacent to other features 66 and within a threshold spatial distance of one another. Design feature 66 ultimately corresponds to elements of a radiation-patterning tool ~~which~~ that may be used for printing one or more patterns on a ~~radiation-sensitive~~ radiation-sensitive material. As interference is a function of the additive effects of radiation, a zone or ring is defined by a radius about the feature where other adjacent radiation could pose an additive effect. The threshold spatial distance utilized in identifying design features in the present methodology is about eight-tenths of the wavelength divided by the numerical aperture.

Please amend paragraph **[0039]** as follows:

[0039] An algorithm used to generate a radius circumscribing the design feature is computed by calculating a radius 68 and forming corresponding diffraction rings 70 around each design element. It should be appreciated that the diffraction rings do not extend between actual elements of a radiation-patterning tool but rather circumscribe design features corresponding to a mathematical construct for calculating the sidelobe convergences. Once diffraction rings 70 have been identified, locations that may be susceptible to sidelobe convergence or overlap are identified. Sidelobe convergence or overlap occurs at locations where one diffraction ring from one design feature intersects a second diffraction ring of a second design feature. Locations 72, 74 and 76 identify ~~intersects~~ intersections of the respective diffraction rings 70. These

intersecting locations identify regions where electric-field energy of radiation sidelobes may become additive or converge, resulting in corresponding areas that may be susceptible to inadvertent patterning.

Please amend paragraph **[0040]** as follows:

[0040] The mathematical construct 64 illustrates design features 66 that may be closer to one another than others of the design features, resulting in multiple potential sidelobe interaction locations, namely locations 72 and 74, which would not typically be discerned through other prior art techniques. After the sidelobe overlap regions are located within mathematical construct 64, the construct is utilized to form a radiation-patterning tool. Such radiation-patterning tool comprises elements corresponding to design features 66 and also comprises the mathematical sidelobe inhibitors 77 (e.g., phasing regions) formed across at least some of the regions of the tool corresponding to the identified sidelobe overlap locations. FIG. 11 illustrates the conversion of the design features and corresponding sidelobe inhibitors from a modeling or construct domain into a real or ~~radiation-patterning~~ radiation-patterning tool domain illustrated as the radiation-patterning tool 78. In FIG. 11, radiation passing through windows or elements 80 may result in undesirably exposed locations ~~which~~ that were calculated and are protected by the addition of sidelobe inhibitors 82. The dimensions of sidelobe inhibitors 82 will typically be about one half of the wavelength of radiation passed through radiation-patterning tool 78. Sidelobe inhibitors 82 may be formed by etching an opaque material associated with radiation-patterning tool 78 to form regions where radiation will be in phase with the main lobe and, thus, out of phase relative to other portions of the sidelobe radiation. Such destructive interference assists in the cancellation of a significant amount of intensity from the combined sidelobes.

Please amend paragraph **[0041]** as follows:

[0041] FIGS. 12 and 13 illustrate further methods for determining locations of sidelobe interaction and, ultimately, locations for placement for sidelobe inhibitors on a

radiation-patterning tool. FIG. 12 illustrates a mathematical construct 84 having design features 86. Respective diffraction rings 88 are generated about each of the design ~~elements~~ features 86 for a determination of convergence of sidelobe energies. As illustrated, intersections of diffraction rings 88 identify locations 90, 92, 94 and 96 ~~which~~ that represent potential sidelobe convergence locations. In FIG. 12, convergence locations 90 and 96 are located an appreciable distance from any others of the sidelobe convergence locations. However, sidelobe convergence locations 92 and 94 are relatively adjacent to one another and, according to the previously disclosed embodiment with regard to FIGS. 10 and 11, sidelobe inhibitors would be placed at both regions about locations 92 and 94, resulting in sidelobe inhibitors that encroach or nearly touch one another. Placement of sidelobe inhibitors in close proximity to one another may present design verification issues as well as mitigate the benefits associated with sidelobe inhibitors. Accordingly, an exemplary embodiment of the present invention contemplates a methodology and algorithm for determining when a plurality of sidelobe convergence locations is preferably substituted with a lesser number of locations for better facilitating any verification and/or sidelobe convergence suppression benefits.

Please amend paragraph **[0043]** as follows:

[0043] FIG. 13 illustrates the formation of a radiation-patterning tool from the mathematical construct of FIGs. 12 and 12A. After the sidelobe overlap regions are located within construct 84 (FIGs. 12 and 12A), the construct is utilized to form a radiation-patterning tool 110. Such radiation-patterning tool 110 comprises elements corresponding to design features 86 and also comprises the sidelobe inhibitors (e.g., phasing regions) formed across at least some of the regions of the tool corresponding to the identified sidelobe overlap locations. In the present embodiment, it is desirable to identify adjacent sidelobe inhibitors that are proximately undesirable. FIG. 13 illustrates the conversion of the design features and corresponding sidelobe inhibitors from a modeling or construct domain into a real or radiation-patterning tool domain illustrated as the ~~radiation-patterning~~ radiation-patterning tool 110. Tool 110 includes windows or elements 114 with

sidelobe inhibitors 116 identified according to the overlap procedures previously described. The calculation of a common sidelobe inhibitor 112 results from the proximate location procedure of FIGs. 12 and 12A. The dimensions of sidelobe inhibitors 112 and 116 are typically about one-half of the wavelength of radiation passed through radiation-patterning tool 110. Sidelobe inhibitors 112 and 116 can be formed by etching an opaque material associated with radiation-patterning tool 110 to form regions where radiation will be in phase with the main lobe and thus out of phase relative to other portions of the sidelobe radiation. Such destructive interference assists in the cancellation of a significant amount of intensity from the combined sidelobes.